CHAPTER IV BASIC MATHEMATICS AND CALCULATIONS FOR CONSTRUCTION

MATHEMATICS

Fundamental Ideas in Geometry:

Many of the basic ideas in geometry are used by people every day. A contractor uses geometry in dividing his site into slabs, in figuring concrete and in planning a roof. The contractor continually makes use of geometric principles. He knows that he cannot turn a five-sided nut with an ordinary wrench. He is familiar with the circle, the square and various geometric forms as they enter into tools and land usage. When he does carpentry, he uses geometry constantly. Every use to which he puts his square depends upon geometry. We see geometric forms of utility and beauty on every side, in forms of nature, in buildings and bridges and in the field. In the study of geometry we are concerned with these forms in classifying and naming them, and in applying the facts of geometry in a definite and systematic manner to practical problems that arise in our work.

Angles:

Two straight lines that meet at a point form an angle. See Figure 46. The idea of what an angle is, being a simple one, is hard to define. One should guard against thinking of the point where the two lines meet as the angle. This point is called the **Vertex** of the angle.

The two lines are called the **Sides** of the angle. The difference in the direction of the two lines forming the angle is the magnitude, or size, of the angle. An angle is read by naming the letter at the vertex and at the ends of the sides. When read in the latter way, the letter at the vertex must always come between the two others. Thus, the angle in Figure 46 is read "the angle B", "the angle ABC", or the "angle at B."

The symbol < is used for the word angle. In this way we write <ABC for angle ABC and <A for angle A.

If one straight line meets another so as to form equal angles, the angles are **Right Angles.** In Figure 47, the angles ADC and BDC are each right angles. If a right angle is divided into 90 equal parts, each part is called a **Degree.** It is usually written 1°.
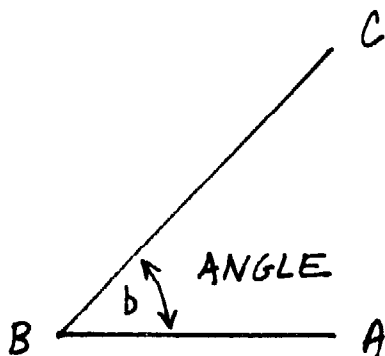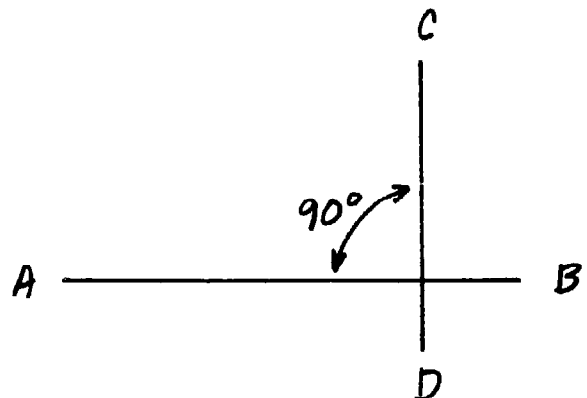
Figure 46 Figure 47

Applied Geometric Formula for Area and Volume:

The importance of a geometrical form in the study of practical mathematics is determined to a great extent by the frequency of its occurrence in application. In construction work, the rectangle is more frequently seen than other forms. There are also several other geometric shapes that are important. The following shapes and formulas have been identified as useful to builders.

Area of a Rectangle:

Find the area of a rectangle 6 feet x 3 feet.

A = L x W

A = 6 ft. x 3 ft. = 18 sq ft.
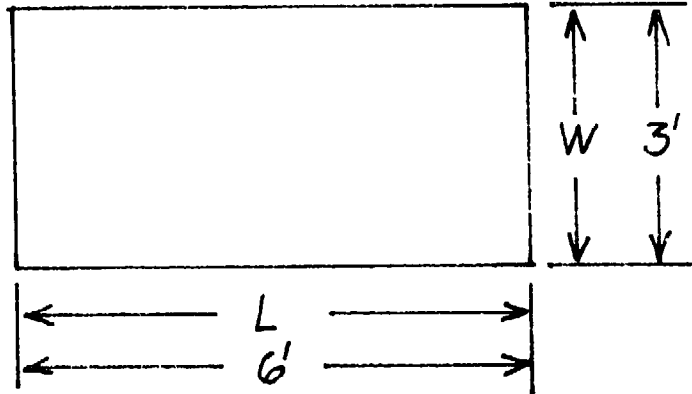
Figure 48

Area of a Parallelogram:

Find the area of a parallelogram.

H = 2 ft. and L = 5 ft.

A = H x W

A = 2 ft. x 5 ft. = 10 sq. ft.
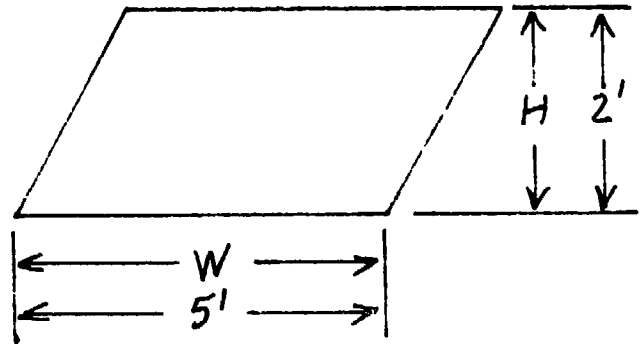
Figure 49

Area of a circle:

Find the area of a circle with a 3 ft. radius.

A = Pi (3.1416) x r^2

A = 3.1416 x 3' x 3' = 28.2744 sq. ft.
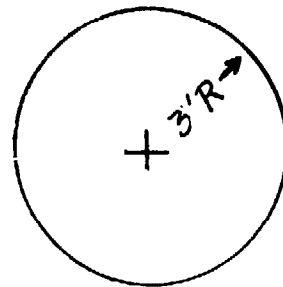
Figure 50

Surface of a Sphere:

Find the square feet of surface area on a sphere 4 ft. in diameter.

$S = 4\ Pi\ (3.1416) \times R^2 = Pi \times D^2 = 12.57\ R^2$

$\frac{D}{2} = R \quad \frac{4}{2} = 2\ R$

$S = 12.57 \times 2\ ft. \times 2\ ft. = 50.28\ sq.\ ft.$
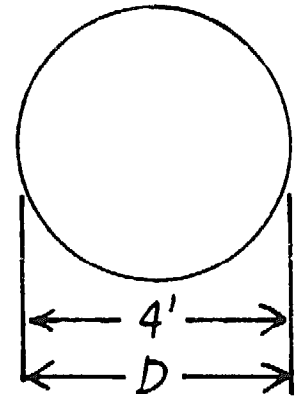
Figure 51

Volume of a Sphere:

Find the volume in gallons of a spherical water container. Inside diameter is 14 inches.

$V = \frac{4}{3}\ Pi \times R^3 = \frac{1}{6}\ PI \times D^3 = 4.189R^3$

$R = \frac{D}{2} = \frac{14}{2} = 7$

$V = 4.189 \times 7 \times 7 \times 7 = 1436.8$ cu. inches.

1 gallon = 231 cu. ins.

$V\ gallons = \frac{1436.8}{231} = 6.22\ gallons$
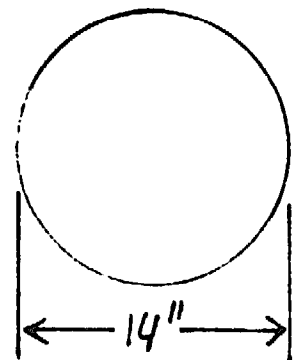
Figure 52

Find the area of a trapezoid:

5 ft. across the bottom. 7 ft. across the top. 2 ft. in height.

$A = \frac{L + L}{2} \times H$

$A = \frac{7' + 5'}{2} \times 2' = 12\ sq.\ ft.$
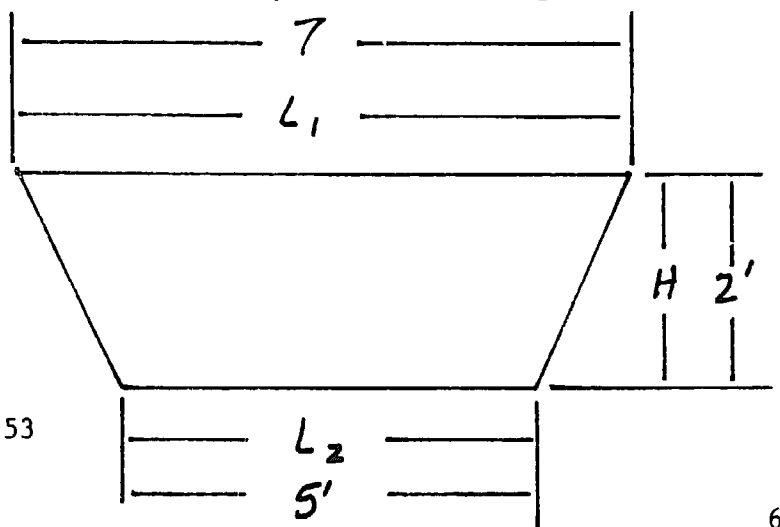
Figure 53

Area of a Triangle:

Find the area of a triangle with a base of 4 ft. and height of 3 ft.

$A = \frac{1}{2} B \times H$

$A = \frac{1}{2} \times 4' \times 3' = \frac{12}{2} = 6$ sq. ft.
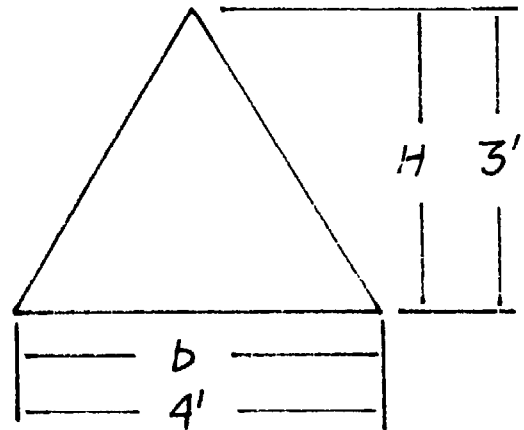
Figure 54

Volume of a Cube:

Find the volume of a cube 3 ft. on each side.

$V = L \times L \times L$

$V = 3' \times 3' \times 3' = 27$ cubic ft. (1 cubic yard)
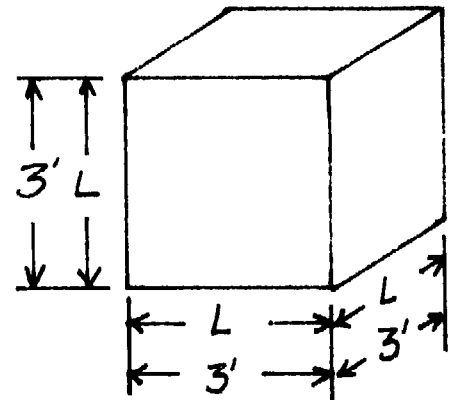
Figure 55

Volume of a Rectangular Prism:

Find the volume of a rectangular prism with a width of 3 ft., height of 3 ft., and length of 6 ft.

$V = 3' \times 3' \times 6' = 54\ ft^3$
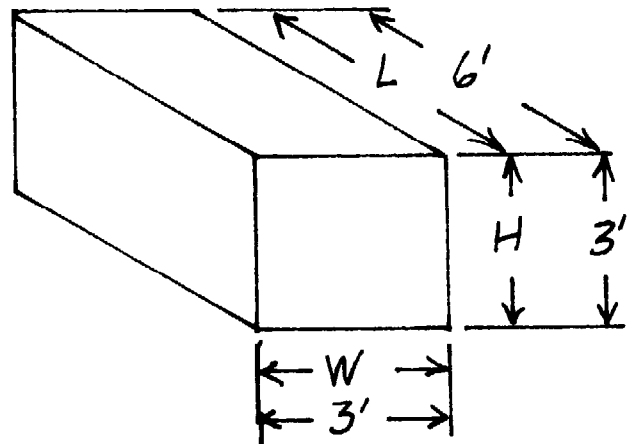
Figure 56

Circumference of a Circle:

Find the circumference of a circle with a 3 ft. radius.

C = Pi x D, or 2 Pi x R

C = 2 x 3.1416 x 3' = 18.8496 ft.
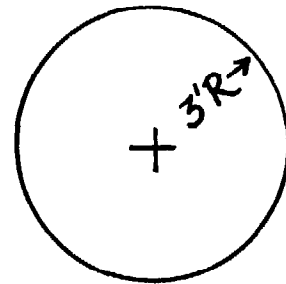
Figure 57

Summary of Formulas:

Parallelogram, Rectangle, Square:

A = ab,
a = A divided by b,
b = A divided by a.

Triangle:

A = ½ ab,

a = 2A divided by b,

b = 2A divided by a,

$A = \sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{1}{2}(a + b + c)$

Right Triangle:

$c = \sqrt{a^2 + b^2}$

$a = \sqrt{c^2 - b^2}$

$b = \sqrt{c^2 - a^2}$

Trapezoid:

$\frac{A}{2} = 1 (a + b) \times h$

Circles:

$C = Pi \times d$

$d = C$ divided by Pi

$C = 2 \times Pi \times r$

$2r = C$ divided by Pi

$A = \frac{1}{2} Cr$

$A = r^2$

$A = \frac{1}{4} d^2 = 0.7854\ d^2$

Segment of Circle:

$$r = \frac{(\frac{1}{2} w)^2}{2h} = h^2$$

$$h = r - \sqrt{r^2 - \frac{(1w)^2}{2}}$$

$$w = 2 \sqrt{h \times (2r - h)}$$

Ring:

$$Ar = A - a^6 = Pi \times R^2 - Pi \times r^2 = (R^2 - r^2) = Pi \times (R + r)\ (R - r)$$